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MacLeay

1833

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TRANSACTIONS

OR

THE LINNEAN SOCIETY.

[1833.]

I. Remarks on the Comparative Anatomy of certain Birds of Cuba, with a view to their respective Places in the System of Nature or to their Relations with other Animals. By W. S. MacLeay, Esq., M.A., F.L.S. Communicated by the Zoological Club of the Linnean Society.

Read Nov. 21, 1826; and April 17, 1827. *24*

THE day is now happily gone past when zoologists thought that the infinite variety of animals which inhabit this globe owed their origin to the unsuccessful efforts of Nature before she could attain the human structure as her term of perfection. Nor is the grand object of comparative anatomy now conceived to be the reference of every animal structure to man,—a mode of viewing Nature that tends to point out distinctions rather than affinities,—but to be the formation of such a collection of recorded facts of comparative organization, as may determine in some degree the use of the various organs; and above all, may lead us to the better knowledge of the natural arrangement of the animal kingdom. For comparative anatomy, independently

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dently of its pathological or medical relation to the human frame, has these two most important objects ; namely, either the ascertainment of the variations of a general plan of structure with reference to the particular exigencies of the species to which such variations are applied, or the study of the variations of general plans of structure with reference to the great plan of creation. English writers on comparative anatomy have rarely looked beyond the first of these objects ; and yet the last is not only the more important of the two, but involves in it the former as a minor consideration or mean by which we may arrive at its attainment. And thus we find, that an anatomist may laboriously investigate the structure and use of an organ, without having the least idea of ascertaining the place held in nature by the animal to which this organ belongs : but no zoologist can be satisfied that he has ascertained the place of an animal in nature, without fully investigating the structure and use of its various organs ; since on this structure and on this use depends all his knowledge of its place. It is therefore to be regretted, that in England the arrangement, or consequence, is so often separated from the facts from which that consequence is, or ought to be drawn ; that, in short, while in one place we see the zoological consequence without the facts from which it has been deduced ; in another we observe the bare statement of anatomical facts, without the great consequences to which these lead, and indeed too often without any view beyond the possible use of the various organs to the particular animals dissected*.

With comparative anatomy, as it may tend to elucidate human pathology or medical science, naturalists perhaps have little to

* Such works indeed as Paley's *Natural Theology*,—a book most valuable not for its physiological facts, but for its mode of reasoning upon them,—have another object ; to wit, the proof of the existence of design in particular structures by the tracing of effects to their respective causes.

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do: but as, to say the least, it is somewhat oracular to advance positions of arrangement without deigning to state the observed facts on which they are grounded, I trust that not merely zoology, but moreover that species of comparative anatomy upon which zoology must always rest as its firmest basis, lies peculiarly within the province of the Linnean Society. A good authority on this subject has said: "L'histoire naturelle d'un animal est la connaissance de tout l'animal. Sa structure interne est à lui autant et peut-être plus que sa forme extérieure*.—Depuis que l'histoire naturelle prend enfin la Nature pour base de ses distributions, ses rapports avec l'anatomie sont devenus plus intimes. L'une de ces sciences ne peut faire un pas sans que l'autre en profite. Les rapprochemens que la première établit indiquent souvent à l'autre les recherches qu'elle doit faire†." If, however, some comparative anatomists will lose sight of the connexion between the two sciences, and thus of the grand object of their art, thereby subjecting themselves to that imputation of dryness and contraction of ideas, which has been (I should hope, rather hastily) applied as well to the English zoologists as comparative anatomists‡, let the zoologist at least free himself from the charge; and by the union of the one science, which affords facts, with the other, that teaches us the mode of arranging them, let him endeavour to approach "cette méthode naturelle unique qui doit faire le but de tous les naturalistes."

I have been led to these remarks, because, subject in a particular degree to error as an individual like myself must always be, who has not had the benefit of a regular anatomical education, I venture to lay before the Linnean Society some observations on the anatomy of birds,—less indeed in the expectation that they can merit attention in themselves, than in the hope

* Cuvier, *Leç. d'Anat. Comp.* vol. 3. p. xxii.

† *Ibid.* vol. 1. p. xvii.

‡ *Ibid.* vol. 1. p. xvii.

that they may induce others, whose opportunities of anatomical research may have been more extensive, to lay the results of their respective investigations also before this Society. Nor, little versed as I am in the study of vertebrated animals, would I even now venture upon this subject, did not my residence in an intertropical climate afford me facilities for examining particular genera, which the more experienced naturalist at home must in vain hope for. And as to restricting our dissections in the present state of natural history to a few European animals, it has been admirably observed, that one solitary species neglected may serve to unfold an exception sufficient to destroy the most plausible system. The following observations, therefore, crude as they are, may derive some portion of value from being linked with the more accurate and scientific researches of ornithologists on European birds ; my aim being to enter upon the description and anatomy of such birds only as present structures peculiar to intertropical countries, comparing them with other birds, which, from being inhabitants of Europe, are better known. I shall not, however, attempt to describe new genera, or name new species, as well on account of my deficiency in the requisite ornithological knowledge, as on that of my inability to refer to large museums and extensive libraries, both of which are indispensably necessary for such undertakings. I need scarcely say, that this department of ornithology is in every respect capable of being infinitely better executed at home.

The general view taken of ornithology by Mr. Vigors in the last volume of the *Linnean Transactions* may easily be conceived to be too interesting to me as an individual not eventually to have made it a most important question with me; as a naturalist, to ascertain the accuracy of his various positions. As, however, I cannot help fearing, that in the course of the investigation he has

has been swayed in no small degree by warmth of friendship,—perhaps, for this very reason, I am the more incapacitated from coming to any correct decision on the merits of his paper. I shall consequently say little on the subject; except that, if any remarks of mine may have withdrawn his attention from the old method of first classifying organs or particular parts of structure, and then arranging animals according to this arbitrary division, and may have induced him, on the contrary, to consider the mode in which the structures of animals vary,—it must be confessed that he has developed, with reference to that mode, one class of animals much further than I have done. Birds now form the only class in zoology which has been arranged according to the variation of structure; that is to say, it is the only class of animals in which a naturalist has attempted, if I may be allowed the expression, to work out the place of every genus hitherto discovered. Every other class of animals, whether vertebrated or unvertebrated, requires still to be *wrought out* in a similar manner; and each genus not only to be placed with reference to its affinities and analogies, but, moreover, the reasons to be given in detail for this position. The great multitude of annulose forms that exist in nature, has given me small hope of ever being able to say that I know the natural position of every described genus in entomology; but I have endeavoured, both in the *Horæ Entomologicæ* and in the first number of the *Annulosa Javanica*, to ascertain the place of some of the genera which constitute the natural group of *Mandibulata*,—a group of the same rank as that of birds.

As to new views or principles in natural history, this mode of studying the variation of structure in different animals, in preference to classing them according to an arbitrary division of organs, is perhaps the only one to which I can justly lay full claim. It is possible, indeed, that Hermann in his very remarkable

able work, entitled *Tabula Affinitatum Animalium*, and published in 1783, may have intended to keep some such principle as this in view: but as with him, unfortunately, the slightest analogy constituted an affinity, we may understand how he found it impossible to trace the mode in which structures vary, and much more so to apply the maxim of variation to arrangement. On a cursory glance at the principles of arrangement laid down by Aristotle* at the commencement of his *Historia Animalium*,

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* It can scarcely be doubted that Aristotle would have followed this principle, as well as have made the proper distinction between affinity and analogy, if he had looked less to the differences of particular organs and more to the affinities of general structures. Indeed he appears to have had a glimpse of the two great principles of natural arrangement, and was only ignorant of the proper mode of using them. His views of the subject are really curious when compared with our modern notions of zoology. The parts of animals, he says, either agree with or differ from each other in four principal ways.—Now here, at the opening, lies the grand cause of his not thoroughly understanding the matter: for if he had said, that Animals themselves, instead of their organs, may be arranged by four methods, it will be manifest, from the enumeration of his four methods, that he could not have failed to arrive at the truth.

1. Organs, he says, may be arranged, first, according to the natural groups (*κατὰ τοὺς γένεας*, or *κατὰ εἴδος*), which, as for instance Birds or Fishes, depend on a similar construction of parts. That relation, he proceeds to state, which the whole bears to the whole, the group being the same, the part must bear to the part. Now this is an axiom which, however true with respect to quantity, will not hold good with respect to structure: for were it true, it would follow that, in the natural group of *Aves*, for instance, a frugivorous bird could not have the same form of beak as a bird of prey; whereas we know the contrary. The fact is, that if Aristotle had said that animals and not their parts are to be arranged according to their natural groups, he would have expressed the great principle of natural affinity: but a mathematical axiom made him unluckily think, that the classification of organs was the same thing with the classification of the animals to which they belong.

2. Secondly, he says, Organs may be arranged according to their excess and defect. (*καθ' ὑπεροχὴν καὶ ελλειψίν*). This being entirely a consideration of quantity, and not of form, his mathematical axiom comes into play. His opinion is accordingly correct, that animals are capable of a binary distribution, depending entirely on the excess or defect of particular organs; as where he instances birds being divisible into those with

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he may also be supposed by some to have understood this doctrine of variation in animal structure ; but it is easy to show, that although this extraordinary man understood it to a certain degree, he confined himself in the passage in question to the division of organs,—a course of reasoning that led him quite away from the conclusions he would indubitably have arrived at, had he followed the variation of general structure. Still I shall not be surprised if the originality of even this principle be ~~one which had but a faint impression on his mind, and which he did not much notice, had not the author of this work, in some part of his work, mentioned the variation of organs in some~~ long and those with short beaks, into those with crests and those without crests, &c. &c. This is the most arbitrary, and therefore, I suppose, the oldest of all modes of arrangement ; and, as Aristotle expressly says, it is so easy, that any one may adopt it. I have said a few words on its merits in the *Horæ Entomologicae*, p. 188 ; but the truth is, that proceeding entirely on the notion of division, and not of affinity, it is a method which is applicable to all sciences whatsoever, as much as to zoology. It has nothing to do with the natural system, which must of course depend upon affinities.

3. Thirdly, Organs may be arranged according to their analogies (*κατ' αναλογίαν*), as, for example, when we compare the claw with a hoof, or the feather of a bird with the scale of a fish : for, says he, what a feather is to the bird, a scale is to the fish. Had he said, that animals instead of their organs may be arranged according to their analogies, it is evident that he would have then distinguished relations of analogy from those of affinity, Aristotle being too profound a logician to use the one word for the other. But the instances given by him to explain his doctrine, prove that the word *αναλογία* in this place signifies *comparison of form* rather than *resemblance in form*. So that the proper translation of the passage is, that similar organs may be arranged according to their difference of structure, as when we compare a claw with a hoof, or, as he himself does in another part of his work, the wing of a bird with the fore-foot of a quadruped. It does not appear in this place very clear, whether Aristotle intended to apply his mathematical axiom, and to say, that organs being arranged in this manner, the animals may also. Although such a mode of reasoning will not lead to any false conclusions, it is far from being an obvious mode, at that early period of natural history, for him to have adopted. If he did not intend to call his axiom into action, he only stopped at the resting-place of comparative anatomists in general, who often trace the modifications of an organ without ever thinking of their use towards natural arrangement. If, on the other hand, he did intend to apply it, my claim to the priority of arranging animals by their variation of structure, would at first sight seem to be in danger. But it remains to be considered, whether in this event his zoological arrangement (making allowance

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some day disputed with me ; for when the question was asked, “Is there any thing whereof it may be said, See, this is new ?” —the answer was, “It hath been already of old time which was before us.” And certain it is, that the doctrines of quinary distribution, of the circular progression of a series of affinity, and of analogies, as distinct from affinities, have all been in some measure advanced by authors prior to the publication of the *Horæ Entomologicae*. Indeed it would add little to our conviction of these being great natural truths, to find that only one writer had observed them, and that others had taken them for granted upon his assertion. Accordingly we learn, that the number five has had an importance in the construction of the

for the difference in point of information) would have been similar to that of the “*Règne Animal distribué après son Organization* ;” that is, a description of animals according to a set of groups founded on a difference of structure ; or whether it would have been an arrangement of animals according to their gradual change of structure. The *Historia Animalium* is conducted on the first plan, not on the last.

4. Fourthly, Organs may be arranged according to their situation (*κατὰ τὴν θέσιν*) ; as, for instance, animals having pectoral mammae, in opposition to those which have them abdominal. Here again his axiom, that the relation which the whole bears to the whole the part must bear to the part, would fail him, if indeed he intended to apply it ; for two tribes of animals widely asunder from each other, may yet have a similar situation of parts. Yet the variation of position of similar parts is one of the most important considerations in zoology, as may be imagined from its being the very principle upon which the *Philosophie Anatomique* of M. Geoffroy Saint Hilaire is grounded.

Apt as we are to adopt methods of arrangement, without investigating the principles by which we are guided, we must always reap advantage from examining the mode of reasoning pursued by one who, although among the earliest of naturalists, was so much in the habit of scrutinizing his ideas. He was aware that animals may also be divided according to their scenes of action, their economy, &c. ; and he has, in fact, given us sketches of such classifications : but he had entered too deeply into zoology not to perceive that these considerations depend on the structure of their organs. He therefore thought, that the best arrangement of animals must depend on that of their organs ;—and so far he was right. I only go a little further than he did, in saying, that this arrangement ought to depend not on that of the organs, but on their variation of structure.

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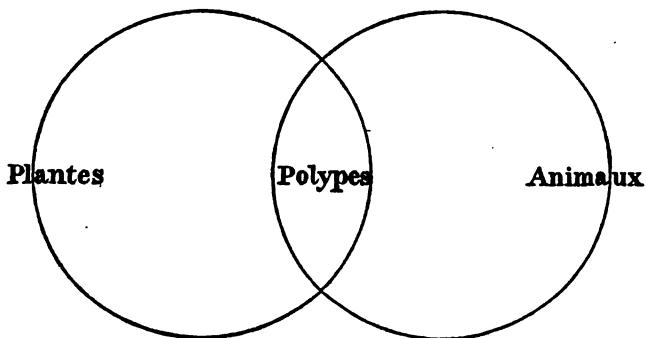
universe given to it from the days of Plato and Cicero*, that Linnæus, Pallas and Desfontaines, have mentioned certain analogies in nature as distinct from affinities†; and that one of the most distinguished zoologists of the present age and a foreign member of this Society, Professor Gotthelf Fischer of Moscow, has stated the progression of certain series of affinity being in circles‡. I can safely say, however, that as I arrived at the knowledge

* The ancient authors on this subject, however, really deserve but little attention: for they all arrived at their conclusions by the *à priori* mode of argument,—a mode totally inapplicable, nay even injurious, to a science like Natural History, which must always depend upon experience and observed facts.

† Aristotle in the *Historia Animalium*, lib. ii. c. 1. says, when speaking of animals generally, *Τα μὲν κατ' αναλογίαν αδιαφορά μονον, τῷ γενεῖ δὲ ἔτερα*. Now if this passage be taken literally, we must give him full credit for making the distinction between affinity and analogy. But I confess, that on looking at the context, and above all, at his explanation of an arrangement *κατ' αναλογίαν*, as above mentioned, I suspect that his idea of analogy did not reach beyond the comparison of organs: as when we say the wing of a bird represents the hand of a man; which comparison, however necessary to the full understanding of the analogies between different beings, is very far from expressing the whole of them. However this may be, it is curious to observe that so little attention should have been paid to this observation of the father of natural history, that “some animals, which agree in analogy, are yet different from each other in affinity.”

‡ It seems to me to be quite unnecessary to discuss in this place what Plato meant by saying, that in nature all things terminate in their contraries,—an expression which Linnæus borrowed in his *Diary*, and appears to have attached meaning to as connected with the number five. Such disquisitions are as little likely to prove satisfactory, as those arguments drawn from the first chapter of Ezekiel, which led a Northern writer, Mr. Macnab, to declare a circle to be the plan of Nature, long before I attained the knowledge of the fact by observation. Naturalists have nothing to do with mysticism, and but little with *à priori* reasoning. I have therefore infinitely less hesitation in citing the following passage from Hermann:—“Neque enim ad affinitatem indicandam per omnem chartæ latitudinem diducere lineam placuit, sed inter nomen et chartæ marginem posuimus asteriscum qui flexa in orbem chartæ incidit in similem alium cuius ope duo in utrâque extremitate posita corpora inter se conjunguntur, unde mirè implicitæ et concatenatæ inque circulum redeuntes affinitates tanto

ledge of these several truths by the observation of Nature alone ; so I first saw their dependence upon each other, their general application, and their necessary derivation, from the practice of studying the method in which animal structures vary. How far shadowy and unconnected notions on the above subjects may affect the claims of the *Horæ Entomologicæ* to public attention I shall not pretend to determine ; but it is my duty, on the other hand, to say, that I was surprised on looking lately among the notes and explanations of the plates (page 181), at the end of a work published at Moscow in 1808 by Professor Fischer, and entitled "*Tabulæ Synopticae Zoognosiaæ in usum Auditorum editæ*," to find the following remarks : " L'auteur trouve dans la Nature organisée une opposition remarquable qui pourroit être exprimée par deux cercles en mouvement, qui se touchent ou qui se croisent en deux endroits.



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magis patescunt."—*Tab. Aff. Anim.* p. 37. Such are the words of a naturalist consummately versed in the observation of facts, as well as in the speculations of philosophy ; but whose learned work is a singular example of the consequences of mistaking relations of analogy for those of affinity, inasmuch as it presents us at the same time with an inexhaustible mine of information, and an almost inextricable mass of confusion. I ought in this place further to mention, that Hermann (p. 8.) cites the following words from Eusebius Nieremberg, *Nat. Hist.* lib. iii. c. 3.—" *Scilicet per contextum Natura assurgit paulatim et sine saltu velut continuâ procedit tramâ. Nullus hiatus*

Les deux points des cercles* qui se touchent, designent deux termes extrêmes, deux circonstances inexplicables pour le naturaliste. 1. La moisissure produite par la corruption des matières animales ; 2. L'origine des animaux infusoires par celle des matières végétales. Les bornes de cet ouvrage ne permettent pas un développement plus ample de cette idée qui présente une vérité à poursuivre." Again, in page 184 is the following passage :—" Il ne faut pas croire que la série des Mammifères soit à considérer dans une direction droite comme une suite. J'ai fait voir à mes élèves qu'elle forme une galerie où l'observateur se trouve au milieu, ayant les espèces d'animaux de ces côtes. C'est-à-dire, l'auteur s'imagine que chaque série de la première division dont les doigts ou pieds ne sont réunis par une membrane, trouvera des analogues parmi les animaux de la seconde division, dont les doigts ou pieds sont réunis par une membrane. Une représentation des genres de Mammifères en cercles entourant le centre où est placé l'homme, et se touchant mutuellement, suivant que les propriétés de differens

hiatus est, nulla fractio, nulla dispersio formarum, invicem connexæ sunt velut *annulus annulo*." Another quotation from Hermann, which, although it relates only to a particular case of the circle, I cannot refrain from giving, as it corroborates the view I take of Reptiles in the *Horæ Entomologicæ*, p. 263, is as follows :—" Demum per Serpentes in circulum quasi per amphibiōrum ordinem rediens affinitas deduci iterum ad primum genus potest, Testudinem. *Testudo serpentina* L. cui caput serpentis, cauda etiam longa quasi serpens inter testudines testas traductus esset. Caudæ apex ungue incurvo armatus quem *Testudo scorpioides* ostendit in serpente aliquo reddit." p. 270.

* It is rather curious to compare this figure with those which I have given, *Horæ Entomologicæ*, p. 212. and *Linn. Trans.* vol. xiv. p. 65. This, indeed, I believe to be the first instance of a diagram being employed to express the relations existing between natural objects; for Hermann's Table, as given at the end of his work, is any thing but a diagram: it is more confused than the *Mappa Geographica* of Linnaeus, or the *nets* more lately devised,—both of which have expressed analogies as if they had been affinities.

animaux se ressemblent seront peut-être la plus conforme à la Nature*."

On the appearance of Mr. Vigors's View of Ornithology, I naturally became anxious to know whether the affinities there stated held good; and on my arrival in Cuba resolved to examine anatomically those forms which, from being extra-European, had been little studied.—My observations on the subject I propose to lay before the Society from time to time, as I may have it in my power to make them; and for the present, I shall preface the description and anatomy of two birds having rather peculiar forms with a few remarks on the affinities of *Vertebrata*, and the comparative anatomy of Birds in general.

Mr. Vigors in his paper has very fully discussed the external structure of this charming class of animals; and by following carefully the variation of their external structure, he has arrived at an arrangement which will be valid to demonstration as the natural one, if by watching the variation of the internal structure we can obtain the same result: for be it always borne in mind, that a natural arrangement will stand any test. It is not that by tracing the variation of one organ we are led to a natural system, and by tracing that of another we are led to an artificial one; since in fact every organ, although not equally convenient, when viewed with reference to the changes it may undergo, leads to the same result, and the variation of all organs is expressed by the natural system†. If it be well said by

* In these few sentences we find the first dawn of so many truths; and as they do not profess to give us more than the dawn, it is unnecessary in this place to state the points in which I differ from Professor Fischer. I owe it to him, however, both as a naturalist and a friend, that I should make the above quotations from a work, which I only became acquainted with last year, when I purchased it at the sale of the library of a lamented member of this Society, Mr. Thomas Smith,—a library well known to naturalists as rich in almost every department of their science.

† See *Horæ Entom.* p. 454.

M. Cuvier,

M. Cuvier, that the natural history of an animal is the knowledge of every thing that regards that animal,—then Natural History, as a science, is only studied in effect when we are engaged in the pursuit of the natural system. It is not, therefore, so much the difference between organs, that we ought to lay stress upon, as the mode in which they vary ; from which truth arises another, namely, that in those groups where the variation of an organ is at its maximum,—or, in other words, where the differences between the various states of an organ are the most,—there such an organ is of less consequence as a principle of division characterizing large groups ; for it is the mode of variation that we ought to attend to. Thus in the *Natatores*, the number of cervical vertebræ is at its maximum of variation ; in the *Grallatores*, the form of the beak is at its maximum of variation ; in the *Rasores*, the number of lumbar vertebræ ; in the *Insessores*, the economy and nature of food ;—and so on. The primary divisions, therefore, of these several large groups of birds, will not depend upon the above respective circumstances, although by tracing the variation of them we are enabled to apply corrections to the place that may have been assigned each species from other considerations, as close to its next of kin in natural affinity.

Generally speaking, *Mammalia* have more vertebræ in their spine than Birds : but this is scarcely to be imagined a mark of their superior perfection ; for man, undoubtedly the chief of *Mammalia*, has one of the lowest numbers of vertebræ that the class presents. The variation of the number of vertebræ in *Mammalia* is not at all conducted on the same principles as that in birds : in the latter class this number varies in every possible way, yet on the whole is tolerably regular in its variation. In *Mammalia* the number in some respects, such as that of the vertebræ of the cervix, is almost constant ; and yet with respect to

to the whole spine, the irregularity of the number of vertebræ is so great, that even neighbouring species,—such as the dog and wolf, the camel and dromedary, the horse and quagga,—differ widely in number. Nay more, the same species sometimes presents a variety of number in the vertebral joints. The difference, moreover, between the maximum numbers of vertebræ in *Mammalia* and birds, as hitherto observed, is 17 in favour of *Mammalia*; while the difference between their respective minimum numbers, as hitherto observed, is 9,—*Mammalia* having also the least. Hence, according to what has been said, the differences of the number of vertebræ in *Mammalia* is of much less consequence, as connected with natural arrangement, than those in birds.

Now let us watch the general variation of the number of spinal vertebræ in birds; for which purpose I must construct my tables upon the data afforded by those which are given by M. Cuvier in his *Leçons d'Anatomie Comparée*, although I am far from conceiving them to be correct.

Orders.	Number of species examined.	Maximum number of vertebræ in the spine.	Minimum number of vertebræ in the spine.	Extent of variation.	Observations.
1. RAPTORES . .	8	40 Pandion.	36 Bullo.	4	
2. INSESSORES . .	21	42 Pica.	33 Loxia.	9	
3. RASORES . .	7	55 Struthio.	37 Meleagris.	18	
4. GRALLATORES	13	46 Scolopax.	39 Numenius.	7	Hæmantopus is excluded, because Cuvier does not give the number of vertebræ in the coccyx.
5. NATATORES . .	12	56 Cygnus.	39 Larus.	17	The Petrel is not included, because Cuvier does not give the number of sacral vertebræ.

Hence,

Hence, so far as we are authorized by these data, we learn, that the variation in the number of vertebræ is least in the *Raptores* and greatest in the *Rasores*: yet, singular as it may appear, there is evidently some species of relation existing between these two orders; which relation made Brisson, in his General Arrangement, and Hermann in his *Tabula Affinitatum*, place them next each other in affinity. The *Phasianidæ* and *Vulturidæ* have been observed to agree in various respects by Buffon, Humboldt, and other naturalists*; and whether we regard the general agreement of the respective orders to which they belong, in the naked cheeks, cera, or form of beak, or of some species in the number of vertebræ, there can be little doubt of the reality of some connexion between them.

Again, on looking at the above table, we find that the number of vertebræ is greatest in the Ostrich and Swan, of all birds; in the former the number of articulations being 55, in the

* See *Humb. Obs. Zool.* on *Vultur gryphus*, Pl. VIII.—It is a story current in the Island of Cuba, that when the Havana was taken by Lord Albemarle in 1762, the English soldiers seeing the *Gallinaza Aura* Vieill. feeding, as it is often accustomed to do, among the domestic fowls in a farm-yard, took them for Black Turkeys; and were only undeceived by the disgustingly putrid odour which these voracious birds emit on being handled. The name under which the bird is known to all our English colonists, namely *Turkey-Buzzard*, and M. Vieillot's generic name *Gallinaza*, adopted from the Spanish as mentioned by Acosta, have both reference to the relation which this Vulture undoubtedly bears to the *Rasores*. See also *L'Histoire du Nouveau Monde*, 1640, p. 145. Hermann says, p. 167:—"Gallinarum cum Accipitribus affinitatem aliquam illud indicare poterit, quod animalis cibi cupidinem qui in cohortatibus nostris Gallinis conspicitur, domesticæ forte vitæ debitum urgeat Buffonius, aut quod incurvum accipitriño subsimile rostrum et magna statura *Tetraonis Urogalli*, vel *Meleagridis Gallo-pavonis* forma colorque et denudatum caput quibus comparare illi *Vulturem Auram* itineratores solent rapacium avium ideam aliquam revocare possit." Aristotle, who seems also to be aware of this relation between the two orders, distinguishes the *Rasores* as *πολυγονα*, and the *Raptores* as *ολυγογονα*. Pliny says, "Alterum Tetraonum genus Vulturum magnitudinem excedit, quorum et colorem reddit:" alluding, probably, to the *Capercaillie*.

latter

latter 56. Now there is also some relation indubitably existing between these two birds, which may serve to account in some degree for that general connexion which almost every observer must have remarked between the *Anatidæ* and Gallinaceous birds*. On comparing the Ostrich and the Swan, we notice, that different as they are in their economy, in the structure of their feet, and even general form, they nevertheless present an approximation in the length of neck, form of beak, vegetable food, enormous crop, muscular gizzard, long cæcums, and, finally, in the structure of the male organs of generation†, so different from those of all other families of birds. These two similar relations existing between the *Raptores* and *Rasores* on the one hand, and between the *Natatores* and *Rasores* on the other, may appear extraordinary: but it would be inconsistent with what I believe to be the general plan of Nature, did they not obviously occur to us; for the opposite points of a circle of affinity always exhibit such alliances, as I first observed in the approximation of the genus *Hybosorus* to *Ægialia*, and of *Euchlora* to *Areoda*‡.

Let us now form another table of the cervical vertebræ, from the same data that enabled us to produce the last; previously to which, however, I may remark, that it is a curious characteristic of the *Mammalia*, that, with the exception of one species, (where it is 9,) the number of cervical vertebræ throughout the class

* "Facies nuda papillosa *Anatis moschatae* quæ præ aliis mansuescit et chortalis fit videtur *Anatis* genus ad Gallinas diducere posse."—Herman. *Tab. Aff.* p. 160. A number of concordances in organization between them may be found detailed in the *Leçons d'Anat. Comp.*

† *Règne Animal*, vol. i. p. 299.

‡ See also *Horæ Entom.* p. 319 and p. 403, where this relation is more developed. It is the *Affinity of Transultation* of M. Agardh (see *Linn. Trans.* vol. xiv. p. 50.), which Mr. Vigors has so well applied to account for the relation existing between the Fissirostral and Scansorial tribes of *Insectores*. (See *Linn. Trans.* vol. xiv. p. 432).

is constantly 7. In birds on the other hand, of all the vertebræ, the cervical vary the most in number; and indeed, on the length and flexibility of the neck, which in this class are generally produced by an increase in the number of joints, depends much of the economy of the species.

Orders.	Number of species examined.	Maximum number of cervical vertebræ.	Minimum number of cervical vertebræ.	Extent of variation.	Observations.
1. RAPTORES . .	8	14 Pandion.	11 Buteo.	3	
2. INSESSORES . .	22	13 Corvus.	9 Fringilla.	4	
3. RASORES . .	8	18 Struthio.	12 Col. passerina †.	6	
4. GRALLATORES	14	19 Grus.	12 Hæmantopus.	7	† I have added one Ratorial bird, <i>Columba passerina</i> , to the number examined by Cuvier, because I find that it presents the minimum number of cervical vertebræ yet observed in the order of <i>Rasores</i> .
5. NATATORES . .	13	23 Cygnus.	12 Larus.	11	

Here then, we first observe that the two Normal groups have the least number of cervical vertebræ, and the three Aberrant the greatest. In the next place, we see that the variation in the number of cervical vertebræ is least in the *Raptores*, and greatest in the *Natatores*. Unfortunately, however, the numbers in two very remarkable genera, *Gypogeranus* and *Tachypterus**, are not known.

The

* Although this bird has only been of late years well known, the important affinity existing between the *Raptores* and *Natatores* was known to Hermann, who says, p. 145:—"Cataractes genus à cl. Brunnichio conditum præcipuè cerè rostri basin tegente differt assimilis hâc in re Falconibus. Poterit adeò qui velit cum istis avibus conjungere, et e Falconibus præcipuè cum *F. leucocephalo*, qui simili ferè modo congeneris *Haliæti* parasitus est: de quâ re vid. Catesby, et *Cataractem Skuam* haud secùs ac *Falcons rapacem* esse terrestremque rapinam exercere et anates gallinas imò agnos prædari Sibbaldus, Willughbeius, Brunnichius fidem faciunt." And again,

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p. 154,

The following table relates to the variation in number of the dorsal vertebræ, or those to which the ribs are attached.

Orders.	Number of species examined.	Maximum number of dorsal vertebræ.	Minimum number of dorsal vertebræ.	Extent of variation.	Observations.
1. RAPTORES . .	8	8 Pandion.	7 Vultur.	1	
2. INSESSORES . .	22	9 Fringilla.	6 Loxia.	3	
3. RASORES . .	7	11 Casuarius.	7 Meleagris.	4	
4. GRALLATORES	14	9 Grus.	7 Ciconia.	2	
5. NATATORES . .	13	11 Cygnus.	7 Pelecanus.	4	{ According to Mr. Burton in the <i>Linnean Transactions</i> , <i>Tachypetes Aquilus</i> has seven ribs.

Here the variation is least in the *Raptores*, and greatest in the *Rasores* and *Natatores*; where again, by the bye, it is worth noticing, that the Swan and Cassowary agree in possessing the maximum number of ribs which the whole class of birds presents.

We now come to a table of the variation in number of the sacral vertebræ, founded on the same data; which table, however, is less perhaps to be depended upon than the others, in

p. 154, in speaking of the genera *Diomedea* and *Phaeton*, he observes, that they appear "non inter se modò cognati ob longissimas alas, altissimum volatum et vivendi rationem, sed et *Pelecano Aquilo* conjuncti eandem ob causam, unde in eadem tabulæ lineâ juxta-positi et cum *Fulcone Haliæto* simili modo in pisces quibus vicitat ex alto irruente conjuncti." I was much pleased, when off the coast of Martinique, to behold the *Tachypetes* floating over the Diamond Rock just like an eagle. The sailors assured me, that he often seizes his prey with his talons; and on referring to the *Histoire Naturelle et Morale des Iles Antilles de l'Amérique*, published in 1658, where there is a very detailed account of the *Fregates*, I find the following passage:—"Ils se placent si bien du costé ou les poissons volans doivent faire leur saillie que dez qu'ils sortent de l'eau ils les reçoivent en leur bec ou en leurs serres." p. 148.

consequence

consequence of these vertebræ being in birds always soldered together, and therefore very difficult to count.

Orders.	Number of genera examined.	Maximum number of sacral vertebræ.	Minimum number of sacral vertebræ.	Extent of variation.	Observations.
1. RAPTORES . .	8	12 Bubo.	10 Buteo.	2	
2. INSESSORES . .	22	13 Corvus.	8 Alcedo.	5	
3. RASORES . .	7	20 Struthio.	10 Meleagris.	10	
4. GRALLATORES	14	15 Hæmantopus.	7 Fulica.	8	
5. NATATORES . .	12	15 Anas.	10 Sturna.	5	{ The Petrel is not taken into consideration, as Cuvier does not mention the number of its sacral vertebræ.

Here we see that the two Normal groups have the least number of sacral vertebræ, and the three Aberrant the greatest. We see also that the number varies the least in the *Raptores*, and most in the *Rasores*.

The fifth and last table that I shall offer relates to the vertebræ of the coccyx.

Orders.	Number of genera examined.	Maximum number of coccygian vertebræ.	Minimum number of coccygian vertebræ.	Extent of variation.	Observations.
1. RAPTORES . .	8 Aquila.	8 Aquila.	7 Pandion.	1	
2. INSESSORES . .	22 Hirundo.	9 Hirundo.	6 Loxia.	3	
3. RASORES . .	7 Struthio.	9 Struthio.	5 Meleagris.	4	
4. GRALLATORES	13 Ciconia.	8 Ciconia.	7 Grus.	1	
5. NATATORES . .	13 Anser.	9 Anser.	7 Anser.	2	{ <i>Hæmantopus</i> is not taken into consideration, because Cuvier does not give its number of coccygian vertebræ.

On reviewing the above five tables, we find that the amount of variation in each order respectively may be expressed by the following numbers :

Normal	{	Raptore	11
		Insessores	24
		Rasores	42
Aberrant	{	Grallatores	25
		Natatores	39

Hence we learn, that the whole number of vertebral joints varies most in the three Aberrant groups, and least in the two Normal ; that it varies much less in the *Raptore*s than in all the other orders ; that it varies the most in the *Rasores* ; and that the degree of variation is nearly alike in the *Rasores* and *Natatores*, and in the *Insessores* and *Grallatores*. We also perceive from the first of the five tables, that the least number of vertebræ occurs among the *Insessores*, and the greatest among the *Natatores* ; the difference between the maximum in *Cygnus* and the minimum in *Loria* being no less than 23 vertebræ.

Among the *Mammalia* the minimum number hitherto observed is in the genus *Pteropus*, and the maximum among the *Cetacea* ; both thus showing a parallelism of analogy with birds. The minimum number is 24, the maximum 73, the difference 49.

I have entered into this subject at some length, not merely because it affords us a curious test of the accuracy of Mr. Vigors's general arrangement of the orders, but also in the idea that it might help to solve a problem of great difficulty ; namely, which two of the five orders of Birds lead us to the contiguous classes of *Mammalia* and *Reptilia* ? The argument may be thus stated :—The vertebral axis is the great characteristic of the sub-kingdom *Vertebrata*, to which all these three classes belong. In Birds, as a class, moreover, we find the number of vertebræ

to

to vary much less than in *Mammalia*; and consequently, to merit in them more attention as a ground of division. Finally therefore, we may conclude, that in that order of Birds where this great principle of structure varies the most, there Nature is—if I may use the expression—looking out for the structure of some other class.

This mode of reasoning is, I am fully aware, not without its defect; but if it can be admitted to possess any value, it follows, that we must look among the *Rasores* and *Natatores* for the outlets from the class. And as there cannot be the least doubt of the *Natatores** approaching to the Chelonian reptiles, we must consequently look among the *Rasores* for the approach to *Mammalia*.

Now this agrees with theory, inasmuch as it is from the two extremes of the three Aberrant groups that we should expect to pass into the contiguous classes.

But this question is of such extreme importance to zoology, that it ought not to be dismissed slightly. I trust, therefore, that I shall scarcely be deemed to trespass upon the time of the Society, if I here attempt to investigate three subjects, which have exercised the ingenuity of naturalists from the earliest periods of their science, and which are as follows:

1. The true analogies existing between the orders of Birds and those of *Mammalia*.
2. The connection of the various orders of *Mammalia* in their own series of affinity†.
3. The point of nearest approach made by *Mammalia* to Birds,

* Bonnet on this account divided the order into *Aves Aquaticæ* and *Aves Amphibiae*. See on this subject *Horæ Entomologicae*, p. 263, et seq.

† I ought here to acknowledge, that the subject of the natural division of the *Mammalia* has been taken up by a writer in the *Annals of Philosophy* for November 1826. This gentleman not only shows much acquaintance with the class in detail, but has ingeniously developed a number of natural approximations. Unfortunately, however,

Birds, and the point of nearest approach made by Birds to *Mammalia*.

In the discussion of these subjects I must not be expected to produce any original facts. This, indeed, would not answer my purpose ; since, in all similar questions, the instrument which is at once safest for the wielder, and most forcible against those for whom it is intended, is the *argumentum ad verecundiam*.

First, as to the orders of *Mammalia* :—there is one to which we must all look with peculiar interest, as being that of which Man forms the type. Great as is the gulf between Man and the Ourang Outang, between the *Bimana* and *Quadrumana* of Cuvier, it is impossible not to see, with Linnæus, that they possess many characters in common*, and consequently impossible not to agree with him, that they form one group, which may be distinguished from all others by the general structure of their

first by not carefully investigating the value of the analogies on record, and then by trusting to the theory of parallelism in preference to the less fallible guide of affinity, he has produced a series, which, in the conclusion, he himself discovers not to be valid. Whether the affinities of his minor groups be of superior value he does not enable us to judge, as no reasons whatever are given for them. This mode of proceeding is the more to be regretted, from his evidently being conversant with the various forms of *Mammalia*, and from his having pointed out the orders in a very lucid manner ; from which I have not failed to derive advantage. This much, I fear, cannot be said of the contents or affinities of these orders ; and therefore, as he has done me the honour of referring to my views of the subject (and his paper, indeed, purports to be a quinary distribution of the class), I may, perhaps, be allowed to express a hope that the question may be followed up. One thing is sure, that nothing can be easier than to make five groups, provided we do not conceive it necessary to prove them to be natural. Having, therefore, stated his propositions, he will be expected to prove them either by original observations of his own, or the recorded ones of others. At present his paper proves nothing, ascertains nothing ; but leaves every affinity to be pointed out. I need scarcely say, that without some such proofs in detail of the connection between the component parts of the group, and thus of its unity, his propositions must remain dubious, and all new names without authority.

* *Aman. Acad.* vol. v. p. 67 *et seq.*

skull,

skull, teeth, fingers, nails, organs of generation, and pectoral mammæ. It is the only order of *Mammalia* that has not been pointed out and named by Aristotle*; but as he has subdivided it, and shown the affinities of the principal groups composing it, it is easy to imagine, that if he could have sacrificed the natural pride of philosophy so much as to class himself with any inferior species of animal, he would have named this group also. Ray may be said to have perceived it, from calling the group $\pi\lambda\alpha-\tau\alpha\pi\pi\chi\alpha$, which evidently includes Man; but by some mistake, he has forgotten to make any mention of Man in his system. This order was aptly termed by Linnæus *PRIMATES*; and the natural construction of it was the most original as well as important fact that he ever demonstrated in the natural history of *Mammalia*.

Another natural group which all zoologists have perceived,

* Notwithstanding the number of ancient and modern writers who have employed themselves in commenting on the *Historia Animalium* of Aristotle, I am not aware that any tabular view has ever been given of this naturalist's arrangement of *Mammalia* and Birds, unless that given by Ælian, lib. xi. c. 37. ed. Schneid. be so considered. This is owing to Aristotle's commentators, with the exception of Ray, Scaliger, and Schneider, being all ignorant of the science. As for Ælian, he was not merely ignorant of natural history, but, moreover, without capacity to understand it, as appears from the manner in which he filled the common-place book, which has come down to us. Aristotle's work is, on the other hand, invaluable. The astonishing talent he possessed for observation and generalization, not merely appears by comparing him with his followers among the ancients, but also when he is compared with the most profound of modern zoologists. The following tabular view of his arrangement, where his own nomenclature is given, will best show the truth of this opinion. How far he has been improved upon either in arrangement or nomenclature, may thus be easily understood. The Table ought in particular to be compared with that given, p. 60 of the *Synopsis* of our great countryman Ray, who perhaps was the most original zoologist, after Aristotle, that ever existed. In mentioning this subject, I do not refer to Pliny, because the few passages of his entertaining work that relate to arrangement are borrowed from Aristotle; and not having been understood in the original, are miserably deteriorated in the translation. Natural History is, perhaps, the last of all sciences that a mere compiler ought to meddle with.

Systema

[Note continued.]

Systema Aristotelicum Mammalium et Avium Cuvieriano Limneanoque comparatum.

EXEMPLA.	
ΔΙΠΟΔΑ	ενθιωνυχα, τα δε τους οδογρας τους προσθιους έχει σέρεις, τους δ' εντος πλατεις, τους δέ τους οδογρας τους προσθιους
1. Τα δε αιμφοδοντα	1. { Τα δε τους οδογρας τους προσθιους { Πιθηκειδα Quadrumania Cuv.
και τας ωνυχας	2. { έχει σέρεις, τους δέ τους πλατεις { Δερματηρα Chiroptera Cuv.
χοντρα	Τα δε μη καρχαροδοντα διον τα γενη Μυιων πολλα Rodentia Cuv.
UNGUILICULATA	Γαμψωνυχα Carnivora Cuv.
3. Τα δε καρχαροδοντα	3. Τα δε καρχαροδοντα { Πετρομενα Amphibia Cuv.
Ray.	4. Πολυτριχιδη Pachyderma Proboscidea Cuv.
TETRAPODA.	5. Δισχιδη { Ακρα Χανδισοντα Pachyderma Ordinaria Cuv.
QUADRUPEDA.	6. Δισχιδη { Τα δε μη χανδισοντα διον δε καμηλος
Auct.	Λας εχοντα UNGULATA Ray.
ΖΩΟΤΟΚΑ.	Κερατοφορα, τα δε λεγεται μητριαζειν Ruminantia Cuv.
Vipara	6. Ασχιδη ανεκαλλατα Solipeda Cuv.
Auct.	7. Τα κηπωδη Cetacea Cuv.
Mammalia	ΑΙΟΔΑ
L.m.	ΑΙΟΔΑ
ΕΝΑΙΜΑ.	Διδακτυλα
Vertebrata	1. Πληκτοφορα Gallinæ Linn.
Lam.	2. Μαρποστελεις Grallæ Linn.
ΩΟΤΟΚΑ.	3. Στρεγανονοδα Anseres Linn.
Ovipara	4. Βραχυστελεις { Τρεις δακτυλοι εις το εμπροσθειν Passeres Cuv.
Τα	5. Δυο δακτυλοι εις το εμπροσθειν Scansores Cuv.
ΖΩΑ.	ΦΟΛΙΔΩΤΑ vel Reptilia Accipitres Linn.
Auct.	ΛΕΠΙΔΩΤΑ vel Pisces.
ANAIMA . . . Invertebrata Lam.	
και τα ΦΥΤΑ επισυναπτομενα αλληλους.	
Struthio.	
Rasores Vigors.	
Phasianus.	
Grallatores Vig. Ardea.	
Natatores Vig. Anas.	
Fringilla.	
Insesores Vig.	
Psittacus.	
Raptores Vig. Aquila.	

is the *καρχαροδοντα* of Aristotle, the *Carnivora* of Ray, and *Fera* of Linnæus. Their claws, their abdominal mammae, and their organs of generation, separate the *Ferae* from the former order.

Another natural group is distinguished from the preceding under the title of *τα μη καρχαροδοντα* by Aristotle; who did not, however, seize its true character*. This remained in obscurity until Ray described certain animals as “*Quadrupeda vivipara pede multifido herbivora binis prælongis dentibus anterioribus in utrâque maxillâ seu Leporinum genus*†.” Linnæus saw the truth of the order as thus characterized, from all others; but changed the name to *Glires*, which has given way among the disciples of Illiger to the clumsy appellation of *Prensiculantia*, and among those of Cuvier, to the very applicable one of *Rongeurs* or *Rodentia*. A Member of the Linnean Society may, however, be permitted to retain the name of *GLIRES*.

Another most natural group was pretty well understood and characterized by Aristotle under the name of *τα μεν ονκ αμφοδοντα*, all other viviparous quadrupeds being *αμφοδοντα*,—that is, furnished with cutting-teeth or incisors in both the upper and under jaw‡. He also described them as not furnished with claws but with hoofs, which occasioned Ray, who understood the value of the group, to call it *Ungulata*, all other quadrupeds being *Unguiculata*. Somehow or other, Linnæus unfortunately lost sight of this group, and contented himself instead with

* It is not clear whether Aristotle placed this group among the *αμφοδοντα* or not. My only reason for thinking he did so is, that he places them in opposition to the *καρχαροδοντα*. If, however, the word *αμφοδοντα* means *circumdentata*,—a signification that it will bear,—then it is clear that he could not have meant the *Glires* to be included in this group.

† *Raii Syn.* p. 204.

‡ *Αμφοδων*, *utrinque dentatus*.

some of Aristotle's subdivisions of it, which are all excellent. The group of **UNGULATA** has not, however, escaped the eye of M. Cuvier.

The last order we have to mention is the *κητῶδη* of Aristotle, *Cetaceum genus* of Ray, *Cete* of Linnæus, and *Natantia* of Illiger. It is in truth a group which cannot fail to strike the most ordinary observer, from the limbs taking the form of fins, and the whole animal the form as well as habits of a fish.

Every Mammiferous animal may be reduced to these five orders; that is, may be assimilated, in a greater or less degree, to one or other of the following typical forms; viz. Man, the Lion, the Horse, the Whale, and the Mouse.

I shall show hereafter how these five orders form a continued series returning into itself, so as to be a natural group. In the mean time, I must recall to the attention of the reader the orders of Birds as defined and arranged by Mr. Vigors*; and to which definitions and arrangement I have just applied so severe a test, only to corroborate their accuracy and to make them display additional harmony.

When we have heard the Parrot or Mainate speaking; when we have witnessed the former feeding itself as it were with a hand; when, in short, we have reflected on the remarkable intelligence and development of brain throughout the whole order of *Insecessores*, to which both birds belong,—there has been no one, perhaps, dull enough not to compare them to *Primates*. *Ælian*[†] says: “Τα μὲν αλλα ταν ἀδικαν οργαν ευστομει, καὶ τη γλωττη φθεγγεται, δικην ανθεπον.” I allow, indeed, that it is difficult to follow the opinion of the great naturalist of France, who, igno-

* *Linn. Trans.* vol. xiv. p. 406, *et seq.*

† Ed. Schneid. lib. I. c. xx. With respect to the particular case of Parrots, I cannot do better than refer to the ample collection of classical quotations given on this subject in the *Zoological Journal*, vol. ii. p. 40, &c.

rant

rant of the true nature of relations of analogy, imagined that the Psittaceous tribe of Birds ought to occupy the first step in the scale of nature below Man: but we cannot help adopting the notion of Linnæus in the *Systema Naturæ*,—that although not near him in construction, they are yet analogous to him in various important respects. And, adopting this notion, we must place the whole order of *Insessores*, to which *Psittacus* belongs, opposite to the *Primates*, of which Man forms the type.

The analogies existing between Birds of Prey and Carnivorous Quadrupeds having been noticed by Aristotle, who called both groups *γαρψωνχα*, were enlarged upon by Plutarch*. Among a host of moderns who have been struck with the resemblance, I may particularly mention Linnæus, who in his *Systema Naturæ* has expressly called his Accipitres “*Feris analogi*;” and Buffon†, who has treated the subject at length and with his usual eloquence. I conceive, therefore, that no one can object to the propriety of my placing the *Ferae* opposite to the *Raptore*s.

The analogy between Aquatic Birds and Aquatic Mammalia scarcely requires the mention of the authority of Linnæus to make it be granted. It is indeed so evident, that Hermann, according to his custom, takes it for a relation of affinity‡. In both orders the anterior appendages of the vertebral axis dwindling into fins, and the two undivided posterior appendages being placed so far behind on the axis as to show that both were intended for motion in the water rather than on land, are circumstances of themselves sufficient to authorize the placing of the *Cetacea* opposite to the *Natatores*.

Two orders still remain in each class to be considered: the *Glires* and *Ungulata* among the *Mammalia*; and among Birds,

* On this subject, see *Zool. Journ.* vol. i.

† Vol. i. p. 37. ‡ *Tab. Aff. Anim.* p. 153.

the *Rasores* and *Grallatores*. The relations of analogy pointed out by Linnaeus between *Mammalia* and Birds are, as Hermann has observed, not always correct; and his errors have arisen from the misfortune of his not detecting the natural group of Aristotle and Ray, which the latter has called *Ungulata*. Having only been able to seize Aristotle's subdivisions of *τα μερικά αμφοδοντα*, he lost the parallelism of analogy, and fell, as I shall hereafter show, into very glaring mistakes. In the *Systema Naturæ*, however, he has mentioned that very striking analogy which appears between his groups of *Grallæ* and *Bruta*; that is, according to the parallelism of analogy, between the orders of *Grallatores* and *Ungulata*, since the *Bruta*, as we have seen, do not form an order, but only a natural subdivision of the *Ungulata*. That this analogy is demonstrably true, I deduce from the following facts. Of their respective classes, the orders of *Ungulata* and *Grallatores* contain examples of the longest legs in proportion to the body,—witness *Camelopardalis* and *Hæmantopus*. Both orders present us, in groups not exactly aquatic, with instances of the toes being soldered together, as the Horse; or connected together by a web, as the Flamingo. Both orders present us with the greatest elongation of muzzle or facies,—witness *Myrmecophaga*, or *Antilope** and *Scolopax*; and also with the most depressed form of muzzle,—witness *Hippopotamus* and *Platalea*, which genera also afford us the truest specimens of Wading *Vertebrata*. In both orders we have the most elongated claws,—witness *Megalonyx* and *Parra*. Both orders afford us the swiftest animals in running,—as the Horse and *Tachydrus*; and the most pugnacious on account of love,—as the Bull and *Machetes*. The Bull moreover and the *Butor* (or *Bos-taurus*, for hence comes the bird's name), afford us the loudest and hoarsest voice of their respective orders: where we have

* Particularly *A. bubalus* L.

also

also the most remarkable instances of the upper and under mandibles touching each other merely at their base and point; as *Myrmecophaga*, or the whole of the *τα μεν ουκ αμφοδοντα* of Aristotle, and *Anastomus** Illig. Both orders exhibit ornamental appendages to the head,—as the antlers of the Stag and the crown of the Crane; and both afford us the only instances of true horns,—as *Bos* or *Rhinoceros*, and *Palamedea* L. To see a hundred such instances of resemblance it is only necessary to walk into a museum. I shall therefore only further say, that both orders contain polygamous animals, are generally gregarious, and more graminivorous than granivorous, being essentially inhabitants of marshes and savannahs. Thus then, with Linnæus, I place the *Bruta*, or rather the whole order of *Ungulata* to which they belong, opposite to the *Grallatores*.

Four orders in each class being now disposed of, it follows by parallelism of analogy, that the *Glires* ought to be placed opposite to the *Rasores*. But setting theory wholly aside,—is this position true in fact†?

Linnæus, from the above-mentioned error in his series of affinity, considered the *Rasores* to be analogous to his group of *Pecora*. But this group, according to Aristotle and Ray, is only a subdivision of *Ungulata*, which have, I consider, been now proved to be analogous to the *Grallatores*. If, therefore, Linnæus be right in making his *Bruta* analogous to the order of Wading Birds, it follows that his *Pecora* must be so also.

* The genus *Aramus*, which I have killed in this island, also presents the peculiarity of the mandibles not meeting towards the middle of the beak.

† The ancient name of *Struthio Camelus*, as well as the form and habits of the Ostrich, show indeed a relation of analogy to the Camel; but then we are to recollect, in the first place, that the Ostrich is at the osculant point or confines of the orders of *Grallæ* and *Rasores*; and secondly, that such slight variations of the parallelism of analogy often appear, although, as has been said, *Horæ Entom.* p. 403, I think it possible that even these are subject to rule.

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The analogy of the *Rasores* to the Ruminating Animals was first, I believe, mentioned by Linnæus in the *Systema Naturæ*. It has since his days been copied and copied, until now it almost becomes a sort of heresy to inquire into its accuracy. I am not, however, aware that any reason for this analogy has ever been assigned, beyond the fact,—that one order affords the principal part of those birds which are domesticated by man for purposes of food; and the other, the principal part of quadrupeds which are destined to the same purpose. Now, granting even this domestication not to be the work of art, but to be an analogy really existing in nature, I would observe,—setting the whole family of *Anatidæ* aside,—that the *Glires* afford us many eatable or domesticated animals, such as the *Capromys* and Rabbit; and the *Grallatores* afford us similar instances in the Snipe and *Psophia*. If some *Rasores* be said, like the *Pecora*, to have ornamental appendages to the head, so it must be remembered has the Crowned Crane; whereas no rasorial bird is truly horned, like the *Palamedea*. But it may be worth while to take into consideration successively the grand characteristics of the *Rasores*, as given by ornithologists to distinguish them from all other birds.

The *Rasores* are, properly speaking, frugivorous birds; by which I do not mean eating fruits only, but all manner of seeds or grain. Now this character of being frugivorous applies much more to the *Glires* than the *Ungulata*, which are truly herbivorous, and only feed on grain in an artificial or domesticated state. To begin, then, with the rasorial or scratching powers of gallinaceous fowls; these are certainly the most burrowing of frugivorous birds: now the most burrowing of frugivorous quadrupeds are certainly not the *Ungulata*, but the *Glires*. These birds are characterized by the shortness of their wings and the weakness of their pectoral muscles. Now if we inquire whether it is among

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the *Glires* or *Ungulata* that we find the corresponding appendages of the vertebral axis,—that is, the fore-feet most shortened,—the answer will be, certainly not among the *Ungulata*; where, on the contrary, the Giraffe has them extraordinarily lengthened: but among the *Glires* we have the Jerboa, in this respect almost a bird. In general, moreover, this latter order is distinguished, like the *Rasores*, by the strength of those muscles of the two posterior appendages of the vertebral axis or hind-feet, that contribute to locomotion. Gregarious habits distinguish the most of the *Rasores*; so they do in a still more extraordinary manner the *Glires*. Many are insectivorous in both orders, and some omnivorous. The muzzle or facies of *Glires* is short and round, very like that of *Ferae*, there being a direct relation between the two orders. The facies of *Rasores* is also short and round, very like that of *Raptore*s (the order analogous to that of *Ferae*); and there is also a direct relation between these two orders. Many *Rasores* perch and nestle on trees; so do many of the *Glires*. The *Rasores* generally feed on hard grain, which they pick up with their hooked beak, and masticate in a triturating gizzard: the *Glires* feed also on hard substances, which they gnaw with their strong hooked incisors, and masticate with their grinders. In both orders the thumb is very often rudimentary. In both orders the tail varies from an extraordinary length, as in the Squirrel and Pheasant, to being very short, as in the Hare and Partridge. Mentioning these two last animals together, we are reminded of a beautiful analogy, stated thus by Hermann, p. 167. “*Tetrao Lagopus, ut et hic aliquam cum Mammalibus analogiam adducamus, triplici respectu Lepori analogus quod digitos subtus lanatos habet, et quod Leporis variabilis more hyeme colorem mutat, et quod carnis sapore et colore leporinam refert.*” No orders in their respective classes present the tail so spread out and flattened as the *Glires* and *Rasores*,—witness the Beaver and

and Peacock. In both orders the sense of hearing is much developed. In both orders we find animals, such as Squirrels and Pigeons, with their toes perfectly free; and others, as *Hydromys* and *Phasianus*, which have them united at the base by a membrane. *Castor* is an aquatic animal, having some relation to *Cetacea*; *Struthio* is a terrestrial animal, approaching to *Natatores*. And so on relation comes so fast upon relation, that I know not how we can for a moment hesitate to place the *Glires* opposite to the *Rasores*.

I conceive it now to be demonstrated, that, so far as relates to the analogies existing in nature between the orders of *Mammalia* and *Aves*, we ought to place them thus:

Animals typically.

1. FERÆ	carnivorous	1. RAPTORES.
2. PRIMATES	omnivorous	2. INSESSORES.
3. GLRIES	frugivorous	3. RASORES.
4. UNGULATA	frequenting the vicinity of water . . .	4. GRALLATORES.
5. CETACEA	aquatic	5. NATATORES.

The above series of Mammiferous orders is only adapted analogically to that of Birds, as given by Mr. Vigors*, and founded by him on relations of affinity. I now, therefore, come to the examination of the second subject; namely, The Connection of the above Orders of *Mammalia* in their own Series of Affinity. And commencing with the *Primates*, as the universally acknowledged point of departure, I find Hermann in 1783 writing of Monkeys as follows:—"Ex alterâ parte minutissimæ istæ Americanæ et delicatulæ species quas Sagoinos vocant, unguibus acutioribus et magis in arcum curvatis, mintriente voce et omnia arrondendi instinctu, ipsâ demum corporis exilitate Glirium familiæ sunt conterminæ. Si enim à *S. argentata* capite recedas, nonne

* *Linn. Trans.* vol. xiv. p. 406.

et

et forma et cauda et ipse quoque pollex tuberculum nonnullorum glirium pollicare referens, muris alicujus majoris esse videatur? Ipsum gliribus nonnullis solenne superius labium fissum reddit in *Simia Midd*: sed omnium maximè ultimam et gliribus magis vicinam *Simiam Jacchum* putaverim, quæ et ipsâ caudæ prolixâ hirsutie et scandendi more *Sciuro* propior est." p. 62. Accordingly we learn that Sonnerat discovered an animal in Madagascar, which was described by Gmelin as *Sciurus Madagascaricensis*; which was by Geoffroy made the type of the genus *Cheiromys*, or Handed Rat; and by Illiger in his *Prodromus* placed next to the genus *Galago*, which is one of the *Primates*. In the *Règne Animal* of M. Cuvier, p. 208, however, this Monkey-Squirrel goes back to its old place among the *Rongeurs*, with a mere hint of its affinity to the *Quadrumana*; which affinity, however, is again reckoned so strong by M. de Blainville, that in the third table of his *Comparative Anatomy* we discover it occupying a place among the *Primates*, as the type of a group to which he gives the name of *Myspitheques* or Ape-Mice. Hence I conclude it allowable to pass from the *Primates* to the *Glires*.

Again: on looking among the *Glires* of Linnæus in the *Systema Naturæ*, ed. 12, I find an animal called *Cavia Capensis*, which obtained this place and name from Pallas, and retained them with Erxleben and Hermann, although the latter says: "E densâ summè affinium animantium turbâ eligemus *Caviam Capensem*, anomalum illud animal, quod ob privam incisorum dentium formam ac situm, inferiorumque quaternarium numerum et totam interiorem structuram separatum ut constituat genus Linnæo et Schrebero promereri visum est, ast alio multo respectu Caviis Americanis, præeunte Pallasio, conjungi dignum. Sed connexum prætereà voluimus cum *Bradyptode*, cui nescio qui habitus formaque corporis contracta, digiti connati, magnusque costarum numerus cognatam faciunt."

unt." p. 83. Hermann finally gave it the generic name of *Hyrax*, which Illiger adopting, placed the animal itself in his *Prodromus*, p. 95, as the link between the *Cavies* and the *Bruta* of Linnæus. In the *Règne Animal*, we discover this puzzling genus forming together with the Rhinoceros one small group of the *Ungulata*, with the observation that, "en les examinant bien on trouve qu'à la corne près ce sont en quelque sorte de Rhinoceros en miniature." (vol. i. p. 240.) Hence it is allowable, I conceive, to pass from the *Glires* to the *Ungulata*.

When Dampier and Ray assigned the name of Sea Cow to the Manati of the West Indies, they probably gave the hint of that anatomical affinity to *Ungulata*, which has been followed up and proved by subsequent zoologists. Accordingly, Linnæus went so far as to place the Manati among his *Bruta*. And M. de Blainville, trusting entirely to the principle of division, and ignorant of the maxim of variation, has said* that, "le Lamantin appartient au groupe qui contient les Elephans dont il n'est qu'une modification propre à vivre dans l'eau." Now, though it is difficult to look at a Manati or Dugong, and call it an Elephant, it is impossible to deny that it is a modification of the Pachyderm form; and therefore we cannot refuse our assent to the accuracy of M. Cuvier in making the Herbivorous *Cetacea* follow the *Ungulata* in the arrangement of the *Règne Animal*.

Arrived thus, then, among those enormous *Mammalia*, which Nature points out to us as the direct medium of her transition from the Quadruped form to that of Fish, we proceed in the series of *Mammalia* to the genera *Trichecus* and *Phoca*. It is true indeed, that M. Cuvier, from the artificial plan of the *Règne Animal*, is obliged to deny this affinity, or at least to make no mention of it in the work: but it has been noticed

* *Dict. d'Hist. Nat. Art. Mammifère*, p. 141.

from

from the earliest ages, and by the most profound as well as ordinary observers. Among the ancient naturalists, Aristotle, and among the moderns, Linnæus, Buffon, Hermann, and Illiger, may be especially mentioned as expressing this affinity: and the following words of Hermann are too apposite not to be quoted.—“ *Trichecorum ultimus utique esse videtur Manatus, cui jam palmæ in digitos non distinctæ nec unguibus armatæ, nullique posteriores pedes sunt; sed Rosmarus plantarum præsentiâ Phocis propior exsertis dentibus de reliquo cum Hippopotamo conjunctus.*” *Tab. Aff.* p. 127.

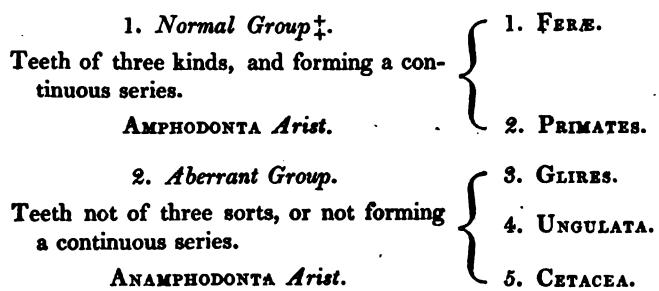
Our business is to represent faithfully affinities and analogies as they occur, leaving it to time to smooth away difficulties. Although this affinity, therefore, does not coincide with the plan of the *Règne Animal*,—and we cannot refute the assertion that there exists a direct relation between the *Trichecus Manatus* and *Trichecus Rosmarus* of Linnaeus,—we must on the other hand grant to M. Cuvier, that *Trichecus Rosmarus* comes most nearly to *Phoca*. But does this admission interfere in the least with our plan? Quite the reverse. Our only object is to keep close within the road of affinities; and our advantage in thus following the variation of structure is, that every natural relation, mentioned even by such authors as Hermann, may thus be expressed; and none need be denied merely because they do not fall in with our systems of division.

We thus, therefore, arrive from the *Cetacea* among the Carnivorous Quadrupeds or *Feræ*; for since the time of Aristotle, who placed the Seal among his *καρχαροντα*, naturalists have never denied this order to be its proper place. Hermann, indeed, places *Phoca* among that group of *Compeda* in which he ranges the Whale; but then he does not the less make it the direct link between that group and the *Feræ**.

* *Tab. Aff. Anim.* p. 115.

Being now legitimately arrived among the essentially carnivorous animals, I may be charged with having omitted to express that most evident affinity which all authors have remarked between the *Primates* and *Feræ*. This affinity, it will be said, must be granted to exist in nature, whether with Linnæus we place the Bats among the *Primates*, or whether with M. Cuvier we range them at the head of this naturalist's group of *Carnivores*. It is equally true, whether with Schreber, Hermann, and Illiger we pass from *Lemur* to *Didelphis**, or whether with Linnæus and Erxleben, we place the Opossums among the *Feræ*.

But if by carefully following the progression of affinity, we have thus returned to the order of *Primates*, from which we departed, the group is a natural one†; and the following series, connected by affinity, harmonizes perfectly with that arrangement which we before acquired by comparing them analogically with Mr. Vigors's series of Birds.



On reviewing this series, we must recollect that there is an universally acknowledged connection between the *Feræ* and the *Glires* by means of the Marsupial Animals, or *Marsupiaux* of

* See on this subject particularly, *Tab. Aff. Anim.* p. 63.

† See *Linn. Trans.* vol. xiv. p. 55.

‡ The Normal and Aberrant groups were distinguished and named by Aristotle in his *Historia Animalium*, but have not to my knowledge appeared again in any work, until Mr. Gray had the honour of reviving them in the *Annals of Philosophy*.

Cuvier,

Cuvier*; some, such as *Dasyurus cynocephalus*, having the dentition as well as habits of the *Feræ*; while others, such as *Phascolomys*, present us with the structure of a *Rongeur*. There is also some sort of relation existing between the *Glires* and *Cetacea*, as Hermann[†] mentions in alluding to the Beaver and Manati. Hence we get two affinities of transmutation or species of relation, which are exactly parallel to those which we have seen existing in Birds between the *Raptores* and *Rasores*, and between the *Rasores* and *Natatores*.

It is a fact as extraordinary in itself, as humiliating for the modern zoologist, that not one of the principal groups of Birds, as given to us in the *Règne Animal*, escaped the keen eye of Aristotle; nay, there is not one of the orders that has not been named by him. It must still give us a more ample notion of the ancient naturalist's skill in zoology to find, that not one of Cuvier's principal groups of *Mammalia* was unknown to him, except the *Marsupiaux* and *Edentés*. And, independently of these curious animals being principally natives of the New World, we may conclude that he never saw an example of either group; else, from the attention he paid to the system of generation and of dentition in the animals he has described, these groups could not have escaped him.

The *Edentata* have always been reckoned to be a very anomalous group of animals, and yet they appear essentially necessary for the fulfilment of the general plan of Nature. These interesting quadrupeds are divided by M. Cuvier into three smaller groups, of which the types may be considered to be the Sloth, the Armadillo, and the Duck-Bill or *Ornithorhynchus* of New Holland. Now, with respect to the *Bradypoda*, Hermann says, p. 64: "Primitibus cognatum est genus *Bradypodis* mammis pectoralibus et aliquali habitu ob quem quondam Linnæus

* *Règne Animal*, vol. i. p. 170.

† *Tab. Aff.* p. 37.

cum

cum Primatibus conjunxit, cæterum moribus et ingenio immensum distans." M. Cuvier also, alluding to the remarkable structure of the arteries in the limbs of the Sloth, says: "Cette structure se rencontrant aussi dans les *loris* dont la démarche n'est guère moins paresseuse, il serait possible qu'elle exerçât quelque influence sur la lenteur des mouvements*." Having thus established an affinity in the Sloth to the genus *Stenops* among the *Primates*, we find Hermann again saying, in the same page, "Anomalum *Bradypodis* genus cum *Pecoribus* connecterem ob quatuor ruminantes ventriculos;" and we find Cuvier in the *Règne Animal* alluding to the same relation†. Hence I conceive that the *Bradypodæ* will be allowed to connect the *Primates* and *Ungulata*. But Hermann, p. 64, connects the *Bradypodæ* with *Myrmecophaga*, as well on account of the strong nails reflexed under the palm and incapable of separate motion, as of their deficiency of incisors. In this opinion he is followed by Desmarest, Blainville, and Cuvier. Indeed, as Desmarest says, the fossil animal *Megalonyx*‡ makes the direct transition from the Sloth to the Ant-Eater; while on the other hand, the genus *Echidna*, which was described first by Shaw as a *Myrmecophaga*, and then by Home as an *Ornithorhynchus*, is universally now allowed to be the link between these two genera. A number of circumstances have made naturalists consider the *Ornitho-*

* M. de Blainville, both in the *Bull. de la Soc. Phil.* 1816, and in the 3rd table of his *Principes d'Anatomie Comparée*, calls them, *Quadrumanes Anomaux organisés pour grimper*.

† In the *Leçons d'Anatomie Comparée*, M. Cuvier makes his family of *Tardigrades* to be the means of transition from the *Edentés* to his *Pachydermes*. In the *Règne Animal*, he places them among the *Edentés*, with the remark, that the whole of this group are furnished with "de gros ongles qui embrassent l'extremité des doigts, et se rapprochent plus ou moins de la nature des Sabots." Linnæus, as it is well known, placed them among his *Bruta*, with the Elephant and Rhinoceros.

‡ See Art. *Megatherium*, Dict. d'Hist. Nat.

rhynchus

rhynchus as approaching the quadruped Reptiles much more than Birds. Thus, being arrived at an Oviparous animal (or at least one that is close to the oviparous structure) and a Reptile form, we detect a connection between the opposite points of the circle of *Vertebrata*; that is, between the *Mammalia* and *Reptilia*, analogous to those relations we have already seen in groups of lower rank existing between the *Raptores* and *Rasores*, between the *Ferae* and *Glires*. Aristotle and Ray had both some vague idea of a relation between Viviparous and Oviparous quadrupeds. But Hermann, although the *Ornithorhynchus* was unknown to him, has positively expressed it in the following words: "Ab iis autem (i. e. à *Myrmecophagæ* et *Dasypodis* generibus) transitus est ad *Lacertas* et *Testudines*, quarum illas squamis suis *Manes* has scuto *Dasypodes* referunt."

The following series, therefore, forms as it were a diameter of the circle of Vertebrated Animals*, passing from the *Mammalia* to the *Reptilia*.

Primates }
Ungulata } Bradypodæ—Dasypodæ—Monotremes *Cuv.*—Reptilia.

I am far, however, from wishing it to be supposed that I think the *Edentata* do not all, or at least in some degree, enter into the group of *Ungulata*. Although this order requires still to be *wrought out*,—until which be done, nothing can be considered as ascertained on the subject,—I see an evident analogy between certain *Edentata* and the genus *Hystrix*, which for the present I can only attribute either to their being in contiguous orders, or to the circumstance of distinct relations of analogy existing between the group of *Dasypodæ* Gray, and of *Talpidæ* Gray, which last are certainly Carnivorous animals. To explain what I mean by the last of these alternatives, I shall first cite

* See diagram, *Horæ Ent.* p. 318.

the

the following words of Hermann:—"Sed *Dasypodis Manisque* armatum corpus et in globum sese contrahendi instinctus ex eâdem *Mammalium* classe statim *Erinaceum* revocant *Dasypodi* connexum quique non modò proximè distantes *Sorices Talpæque* sed et interjectâ *Hystrice* omnem *Glirium* familiam post se trahit." I shall next, in compliance with this hint, place the principal animals of the three groups in such a way as that the zoologist can determine for himself, whether any or what relations of analogy exist between them.

<i>EDENTATA</i> Cuv.	<i>GLIRES</i> Linn.	<i>INSECTIVORA</i> .
Echidna* Cuv.	Echimys Geof.	Mygale Cuv.
{ Ornithorhynchus Bl.	Spalax Guild.	Talpa L.
Myrmecophaga L.	Sciurus L.	Tupaia Raff.
{ Chlamyphorus Har.	Hydrochoerus Erx.	Centetes Ill.
Dasypus L.	Hystrix L.	Erinaceus L.

I do not attempt to dilate upon this very important subject, because I have not yet bestowed upon it the attention which it requires. The zoologist is left therefore to form his own conclusions, when he may have studied those very interesting pages of Hermann[†], in which this learned naturalist gives his reasons at length (unfortunately too long to quote here) for the existence of relations between *Erinaceus* and *Hystrix*, between *Sorex* and *Mus*, between *Sorex* and *Elephas*, between *Mygale* and *Castor*, *Sorex* and *Talpa*, and finally, between *Spalax* and *Talpa*. If these relations be true in nature, they are all analogical and expressed in the above table, except the relation between *Sorex* and *Talpa*, which is one of affinity.

In some such manner as this would it appear that Nature,

* *Echidna* is, according to Cuvier, connected with *Myrmecophaga* by means of its extensible tongue and habits. *Myrmecophaga* is connected with *Dasypus*, according to the same authority, by means of the singular genus *Orycteropus*.

† *Tab. Aff. Anim.* p. 78 et seq.; p. 90 et seq.

passing

passing from the viviparous quadruped structure, approaches to that of the oviparous quadrupeds. And it would be an interesting subject of inquiry to know, whether the affinity of transmutation in the sub-kingdom of *Annulosa* takes place in a similar way. In Annulose animals, all relations of this kind are usually concealed by Nature under the mask of metamorphosis, as I have shown in the *Horæ Entomologicæ*, p. 403; but the remarkable relation existing between the larvæ of *Neuroptera*, such as *Myrmeleon*, has not escaped the notice of naturalists.

The circumstance most deserving of remark in *Mammalia*,—although it may possibly be the same in all the typical groups of the sub-kingdoms,—is, that the affinities of transmutation, which are only visible in smaller groups by means of one or two species, become here visible by means of whole groups of animals. This, instead of rendering, as might have been expected, such intricate relations more easily understood, has in fact been the great obstacle to the natural arrangement of the class.

We are by this time, I trust, in some degree enabled to discuss the third subject: namely, what *Mammalia* make the nearest approach to Birds, and what Birds make the nearest approach to *Mammalia*?

There are three kinds of quadrupeds that possess the power of flight,—Bats, Marsupial Animals of the genus *Petaurus*, and Glirine Animals of the genus *Pteromys*. We have seen that the Marsupial Animals do not enjoy any distinct form*, but serve

* "Les Marsupiaux que nous rangeons à la fin des carnassiers, comme une quatrième famille de ce grand ordre, pourraient presque former une ordre à part, tant ils offrent de singularités dans leur économie. Malgré une ressemblance générale de leurs espèces entre elles, tellement frappante, que l'on n'en a fait long-temps qu'un seul genre, elles diffèrent si fort par les dents, par les organes de la digestion, et par les pieds, que si l'on s'en tenait rigoureusement à ces caractères, il faudrait les répartir entre divers ordres. Ils nous font passer par nuances insensibles des carnassiers aux rongeurs." *Règne Animal*, vol. i. p. 169 & 170.

merely as a group connecting the *Ferae* and *Glires* by the affinity of transmutation. A *Petaurus* approaches closely to a *Pteromys*. In the inquiry, therefore, as to the order of *Mammalia* which approaches most nearly to Birds, we have only to consider the *Cheiropтера* and genus *Pteromys*. It is clear, that any animal supporting itself in the air so well as a Bat does by means of wings, must not only have strong pectoral muscles, but a crista to the sternum for their attachment. Herein consists all the analogy which the Bat bears to the Bird. Here ends all connection between them; and the rest of the order to which the Bat belongs have nothing in common with Birds. Let us turn therefore to the *Glires*. On looking at this order, we perceive that here, at least, a remark made by Buffon holds perfectly true. "Quoique tous les Animaux Quadrupedes tiennent entr'eux de plus près qu'ils ne tiennent aux autres êtres, ils s'en trouvent néanmoins qui font des pointes au dehors, et semblent s'élancer pour atteindre à d'autres classes de la nature* :" Now, although the *Pteromys* or Flying Squirrel is perhaps, with respect to powers of flight, not so much of a Bird as a Bat, the order of *Glires*, to which it belongs, makes several attempts as it were to attain the structure of the class of Birds. Indeed, of all *Mammalia*, we find in this order the greatest number of concordances with Birds; so that if we cannot specify any particular genus as nearest, we can on the other hand say, that the whole order comes nearest to that class. *Dipus* gives us the legs and feet of a Bird†; *Sciurus*, the feathers‡; *Hystrix* the quills§; and *Pteromys*, the wings of a Bird. In *Cheiromys* the thumb is, as generally in birds, opposed to the other fingers. Birds have but one exterior opening for the intestinal canal and the organs of generation:—no more has the

* *Hist. Nat.* tom. xiii. p. 330. ed. 4.† *Herm. Tab. Aff. Anim.* p. 117.‡ *Cuv. Règne Anim.* i. 204.§ *Herm. Tab. Aff. Anim.* p. 118.

Beaver.

Beaver. Birds make nests ; and the *Glires* are the only quadrupeds that do the same. But relations of this last kind depending upon economy are to be suspected ; and therefore I would lay more stress on those of structure which,—the sternal crista of Bats being excepted,—are all in favour of the greatest approach to Birds being made by the *Glires*. *Hydrochærus* and *Struthio* are similarly situated with respect to the disappearance of toes. Of Birds, the *Rasores* exhibit the most beautiful developments of tail ; and of *Mammalia*, the *Glires*, among which, —as was before alluded to,—the Squirrel is furnished with distichous hairs constructed like feathers. There can be little doubt of the family of *Struthionidæ* containing those Birds which make the nearest approach to *Mammalia**. This is a point, indeed, which we may consider as proved by Buffon and Hermann. So that, if the order of *Glires* makes the nearest approach to Birds, and the order *Rasores* makes the nearest approach to *Mammalia*, we can imagine the future occurrence of some animal that will render this connexion complete.

The Society will, I trust, excuse this long digression, not merely as an inquiry connected with the accuracy of Mr. Vigors's paper, but also with what is usually reckoned the most interesting branch of Natural History. I believe that I have not stated one relation of affinity or analogy without giving my authority for it. If such relations, when thus all presented to the view, agree most harmoniously with what has been observed in other branches of nature, we scarcely ought to be surprised ; for we have too long and too eagerly scrutinized Nature, not to be convinced that the grand work of creation, so far from having been, as some fancy, in its origin a mass of confusion, even still

* "Grandissimi et penè bestiarum generis *Struthio camelus* Africi vel *Æthiopici*." *Plin. Hist. Nat.* lib. x. 1.

presents something better than the disjointed ruins of a once beautiful fabric.

Confining myself now to the class of Birds, and deeming the structure of their beak, wings and feet, to be points of external anatomy, I conceive that part of their internal structure, which is next in importance to the naturalist after the vertebral axis, to be the digestive apparatus; since on this depends the nature of the food, and consequently the mode of living of the individual.

Hence the variation of structure in the crop, glandular crop, gizzard, intestines, and cæca of Birds, ought particularly to be studied; and, in fact, has always excited a considerable portion of ornithological attention. Yet unfortunately, from that natural tendency which we all more or less possess to generalize carelessly, there has been made a grand division of Birds into Carnivorous and Herbivorous, where the former was characterized by a membranaceous stomach, and the latter by a strong muscular gizzard*. Now this is all erroneous; the fact being that although the length of the intestine may have some relation to the animal or vegetable nature of the food, the muscular structure of the gizzard depends only on its degree of hardness. Thus Birds destined by nature to feed on soft vegetable matter, have a membranaceous stomach; and those intended to prey on hard animal matter, such as Coleopterous or Hymenopterous insects, have a muscular gizzard for trituration. The Humming Bird has a membranaceous stomach; while the *Pendulinus* has a muscular gizzard, although both these genera

* "It is well known," says Paley in his *Natural Theology*, p. 271, "that there are two intestinal systems found in birds:—one with a membranous stomach and a gastric juice capable of dissolving animal substances alone; and the other with a crop and gizzard calculated for the moistening, bruising, and afterwards digesting of vegetable aliment." It is much to be regretted that this work should be full of similar errors; which, being in the hands of almost every one, are perpetuated by those who are ignorant of Natural History.

suck

suck insects out of flowers with the nectar ; but the reason of the difference between them is, that the Humming Bird contents itself with soft *Tipulidæ*, while the *Pendulinus* digests hard *Hy-menoptera*. That the *Trochilidæ* should take animal food, we perceive from their analogy to the *Hirundinidæ* on the one side ; and that they should also take vegetable aliment, we understand from their analogy to the *Psittacidæ* on the other. With both the *Hirundinidæ* and *Psittacidæ* it agrees in that peculiar anatomical characteristic, of wanting an emargination to the sternum.

While on the subject of analogies, I may be allowed to mention a series, which, although it is directly deducible from his diagrams, is not expressly mentioned at length by Mr. Vigors. It is valuable, inasmuch as it may serve to show that the perfection of ornithological structure and intelligence lies among the *Scansores*. Mr. Vigors has proved by a chain of examples, that the five groups of *Insessores* represent the five primary groups or orders of Birds ; and so also it would appear that the five groups of *Scansores* represent the five groups of *Insessores*, and consequently the orders of Birds. For instance, Toucans belong to the group of *Insessores*, so that on this point nothing need be said ; but every one must have also remarked the form of beak and prehensile foot of the Parrot to give it an analogy to the Birds of Prey*.

The backward position of the legs, with reference to the sternum, and the disappearance of the hind toe, with other points of structure in certain species of *Picidæ*, give a common character of analogy to them and the *Natatores*†. The length and curvature

* "Initium facere lubet à Psittaco quam curviostrem avem et instructam cerâ quam Striges Laniique carent, primo loco post Accipitres ipse quoque Linnæus posuit, quin olim cum iis quoque invitâ licet naturâ conjunxerat." *Herm. Tab. Aff. Anim.* p. 181.

† This analogy is the origin of such specific names as *Alca Psittacula* and *Alca Pica*. Hermann says, p. 156: "Pelecanus Carbo rigidâ caudâ quam solis cum Plotis communem

curvature of slender beak are common to the *Certhiidae* and *Grallatores*; while the *Cuculidae* approach to the *Rasores* in such genera as *Corythaix* and *Musophaga*. The following table, therefore, will express several analogical relations of the utmost value.

*SCANSORES.**INSESSORES.**AVES.*

PSITTACIDÆ representing the . . . DENTIROSTRES, and therefore the . . . RAPTORES.
 RHAMPHESTIDÆ joining the . . . CONIROSTRES, and forming part of . . . INSESSORES.
 CUCULIDÆ forming part of the . SCANSORES, and joining the RASORES.
 CERTHIADÆ joining the TENUIROSTRES, and representing the GRALLATORES.
 PICIDÆ representing the FISSIROSTRES, and therefore the . . . NATATORES.

communem habet Picorum generi accedit." And again, (p. 31,) in speaking of the affinities of the Woodpeckers, he says: "Additæ sunt duæ species Pici, *tridactylus* et *semirostris*, quorum hic affinitatem longinquam quidem, sed tamen aliquam cum Rhynchosope, item semirostri ave; ille autem cum Alcedine tridactylâ indicat." Neither of these relations, however, are truly those of affinity; that of *Picus semirostris* to *Rhynchosops* being one of analogy; and that of *Picus tridactylus* to *Alcedo* being one of analogy, or if not, of the affinity of transmutation.